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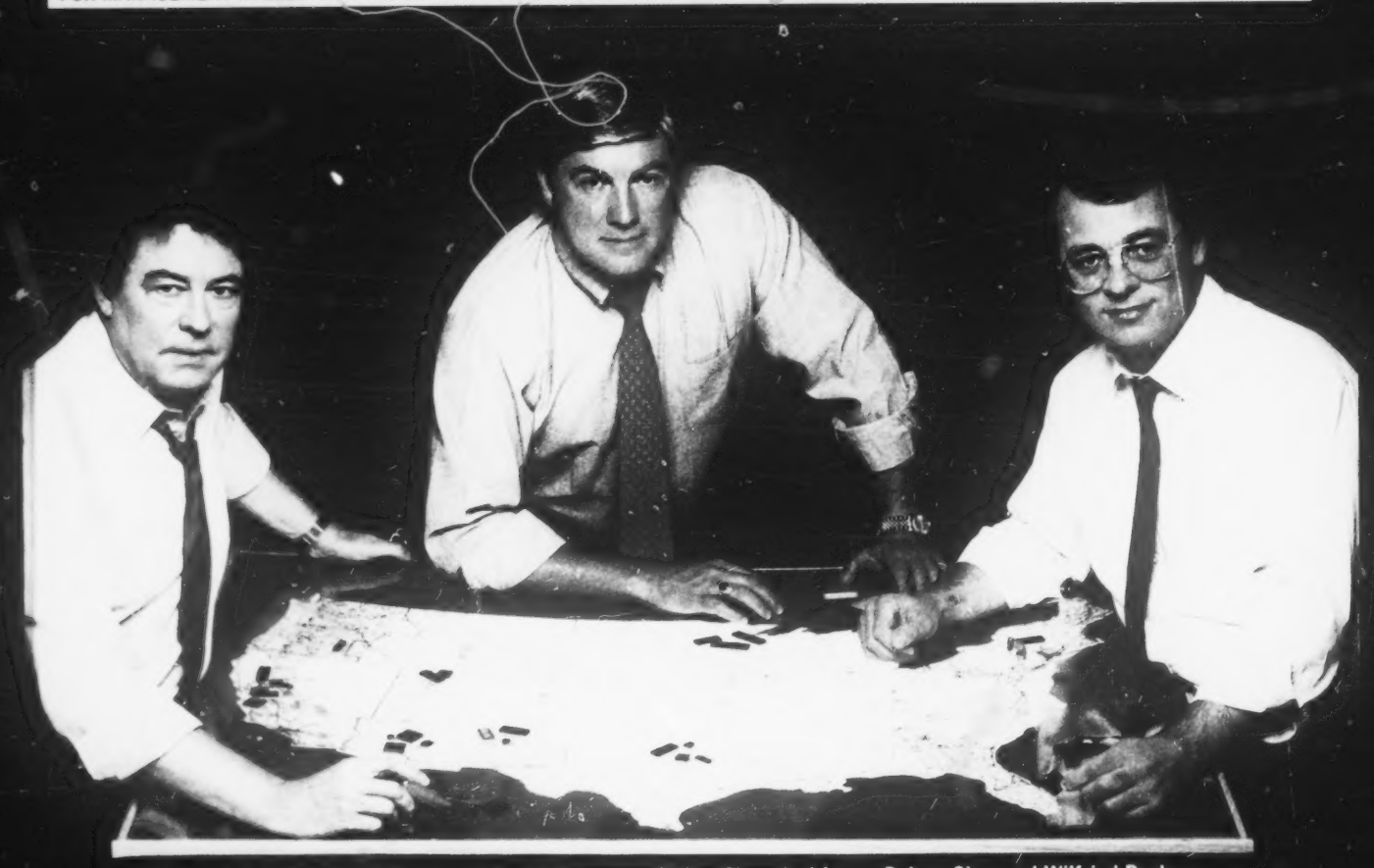
FOR MANAGEMENT IN ELECTRONICS, COMPUTER & SYSTEMS COMPANIES — WORLDWIDE

AUGUST 7, 1989



From left to right: SGS-Thomson's Daniel Queyssac; Philips/Signetics' James Dykes; Siemens' Wilfried Backes

IT'S NOW OR NEVER

European chip makers plot last-ditch assault on U.S.

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The top 100 U.S. R&D spenders PAGE 50

George Gilder: The New American Challenge PAGE 36

Electronic Business

FOR MANAGEMENT IN ELECTRONICS, COMPUTER AND SYSTEMS COMPANIES — WORLDWIDE

VOL. 15, NO. 16 AUGUST 7, 1989

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Enough is enough. That's the sentiment of European semiconductor manufacturers, who despite past failures, aim to be global leaders rather than followers. But in order to take on the world, the Europeans admit they first must take on the United States.

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Modem chipset makers expect the market for their product to expand rapidly now that VLSI technology has brought single chips and lowered prices accordingly.

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24 It's now or never for Europe's chip makers

Despite a more focused U.S. stance the deck might be stacked. The Europeans still must live down their reputations as "marketing-adver..e" companies, perennially afflicted by "techno-lag." But if monetary investment is a measure of commitment, then the Europeans are on the right course: The big three — SGS-Thomson, Philips and Siemens — have spent upward of $1 billion within the past five years to try to make it big in America.

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The first of two excerpts from George Gilder's upcoming book on the semiconductor industry, *Microcosm*. In this part, the best-selling author explains how world wealth has shifted from the form of physical resources to the power of the mind — ideas and technologies. Epitomizing this rise in the source of wealth, Gilder argues, is the microchip.

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50 Top 100 R&D spenders increase investment by 15.7%

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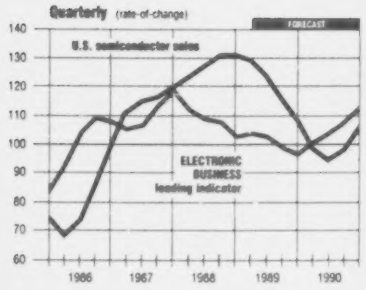
52 Top 100 U.S. R&D spenders

Cover photograph: Christopher Springmann



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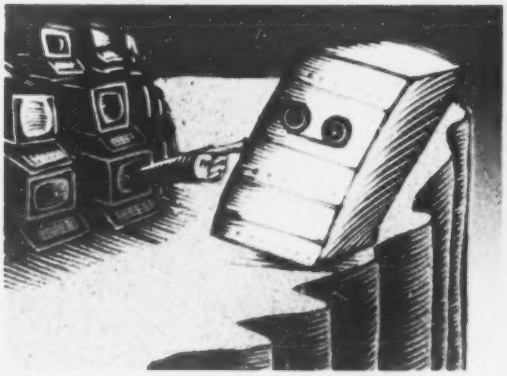

PAGE 36 George Gilder's "The New American Challenge," an excerpt from *Microcosm*

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It is a sign of the times when Cray Research, the supercomputer pioneer, decides that it, too, has to scale back its R&D ambitions. Slowing revenue growth and rising R&D costs has forced the supercomputer pioneer to consolidate its research efforts, ending its obligation to the risky Cray-3.

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EDITORIAL STAFF

Publisher: Frank J. Burge

Editor: Jeffrey Bairstow

Editor-at-large: John Kerr

Managing Editor: Roger C. Plant

Senior Editors: Linda Stallmann (Financial), Bruce C. P. Rayner, Valerie Rice

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Production Editor: Karen J. Covey

Editorial Assistant: Jean O'Brien

ART STAFF

Art Director: Bill Cooke

Associate Art Director: Carla Aguilar Leeder

EDITORIAL OFFICES

Boston: Cahners Building
275 Washington Street, Newton, Mass. 02158
(617) 964-3030 Telex: 94 0573 CPC BSN
Fax: (617) 558-4327 MCI: EBBOS

San Jose, Calif.: Valerie Rice, John McCreadie
Sherman Building, 3031 Tisch Way, Suite 100,
San Jose, Calif. 95128 (408) 296-0868

Irvine, Calif.: Bruce C. P. Rayner
18818 Teller Avenue, Suite 170
Irvine, Calif. 92715 (714) 851-9422

Northwest: Paula Doe
5011 133rd Place SE
Bellevue, Wash. 98006 (206) 641-0903

PRODUCTION

VP Production: Wayne Hulitzky

Director of Production/Manufacturing: John R. Sanders

Production Supervisor: Andrew A. Jantz

Production Manager: Betsy Harkins; (617) 964-3030

CIRCULATION

Group Circulation Manager: Eric Schmierer
44 Cook Street, Denver, Colo. 80206
(303) 388-4511

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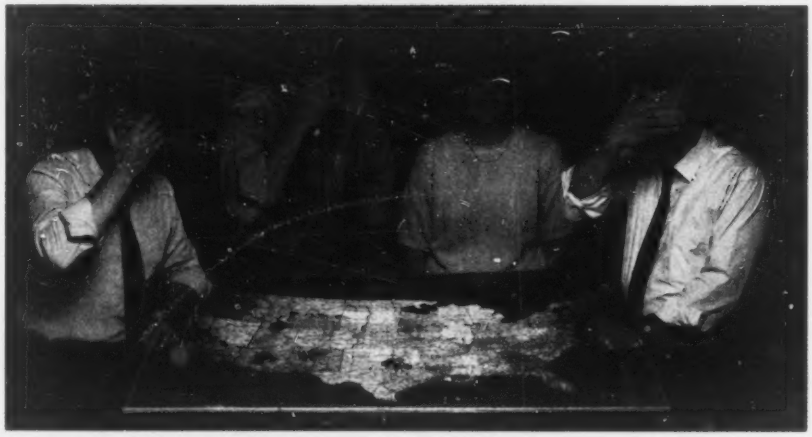
It's now or never



Chris Springmann

Senior editor Valerie Rice and Queyssac, Dykes and Backes

There's a keen sense of desperation these days among Europe's biggest semiconductor manufacturers — that if they don't dramatically increase their static 7% share of the U.S. market the Europeans can dismiss all hopes of being serious worldwide players. Our San Jose-based bureau chief Valerie Rice, who authors our cover story, says the Europeans do realize time is running out.

Valerie spent a month in Europe interviewing executives of Europe's big three — SGS-Thomson, Siemens and Philips. Her travels took her to Paris, London, Milan, Amsterdam and Munich. The European chip makers, long perceived in the U.S. as lagging in technology and marketing, are eager to be taken seriously.

In the photograph that accompanies this column, Valerie is seen during a relaxed moment with three executives of the U.S. operations of SGS-Thomson, Siemens and Philips. The photo, by free-lance photographer Chris Springmann, is the exact set-up as the cover and was shot in San Jose. The mood created is that of a military strategic planning room.

As the cover picture suggests, the European chip makers are plotting their last-ditch assault on the U.S. market. Whether it will work or not is a leading question. Competitors, customers and market experts all have their doubts. As Valerie points out, if Europeans don't get up to speed in the United States there may not be a tomorrow.

Gilder's Microcosm

The central event in the 20th century has been the overthrow of matter, where world wealth has shifted from the form of physical resources to the power of the mind. That view is put forth by best-selling author George Gilder in his upcoming book, *Microcosm: The Quantum Revolution in Economics and Technology*, which explores the meaning and future of modern technology. We think it will be an important book and are excerpting two chapters, beginning with this issue.

MARVIN GREENE, section editor

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It's now or never

for Europe's biggest chip makers

In a last-ditch effort to be global semiconductor players, the Europeans are facing their moment of truth. Can they plot a U.S. strategy that's aggressive enough — or must they forever hold their peace?

BY VALERIE RICE

Enough is enough for European semiconductor manufacturers, also-rans even in their own home markets last year and perennial players in a global game of follow-the-leader. In what many observers see as a last-ditch effort, the Europeans are pinning their hopes for a brighter future on making it big in the U.S. market.

The three European principals — SGS-Thomson Microelectronics, N.V. Philips GL and Siemens AG — have been present in the United States for more than 10 years, but their semiconductor successes have gone largely unnoticed by competitors and customers alike. Now, though, as the U.S. market is being carved into increasingly small chunks by Japanese, Korean and other Pacific Rim companies, the Europeans must make their move — or forever give up an opportunity at the world's second largest semiconductor market.

The Europeans are plotting to take on the world via a renewed assault on U.S. semiconductor business. Quietly, over the past 18 months, European companies have been putting structures into place — second-sourcing arrangements, alliances, larger salesforces and a new attitude — that will support a sustained and vigorous attack on the market.

"We have a couple of years grace time now," says Philips Components' Signetics operation president James Dykes of his company's status. "But if we don't make a big splash soon, we will hurt ourselves in the long run."

But this aggressive stance is something new for the Europeans, who nonetheless may be playing against a stacked deck. European chip makers are typically slow to react to the market, top heavy, and, some market observers say, two years or more behind the United States in technology and marketing. Yet SGS-Thomson, Philips and Siemens have spent upward of $1 billion within the past five years to acquire the technology and even the foothold necessary to make it big in the United States.

"To be a global player, truly global, you have to be in the U.S.," stresses Siemens' Christoph Horstman, the Munich, West Germany, company's components division executive director. "We have been damned late getting into the U.S. I only hope it's not too late."

Trailing the pack

After at least 10 years in the U.S., and in some cases more than 15 years, the Europeans do not have much to show for their presence. Data from San Jose-based

SGS-Thomson's Daniel Queyssac, Philips/Signetics' James Dykes and Siemens' Wilfried Backes, left to right, all have designs on capturing more U.S. market share

Christopher Springmann

market researcher Dataquest Inc. indicates that European semiconductor market share in the U.S. has remained a static 7% of the total market over the past two years. But the Europeans are being outpaced by the upstart Koreans, whose 3% market share last year masks a growth rate much higher than that of the Europeans, says Dataquest's North American IC director Victor de Dios.

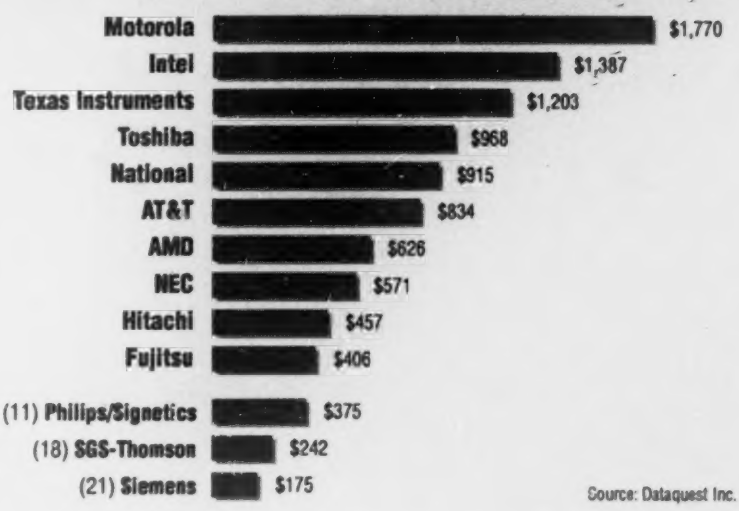
The Europeans have not racked up a lot of technology "firsts" in that time, either. Although global leaders in power ICs, optoelectronics, discretes and analog, the Europeans are not at the forefront of any of the high-growth, cutting edge technologies, according to an informal ELECTRONIC BUSINESS survey of market analysts across the United States.

Signetics Corp., of Sunnyvale, Calif., and its parent Philips are actually losing worldwide — and particularly U.S. — market share. Last year they dropped to a new low — No. 11 worldwide — from a high of No. 3 three years ago, according to Dataquest. In fact, the U.S. market is the only part of the world where Philips actually experienced negative market growth last year; the firm's U.S. revenue declined by 4% in 1988 over 1987. And Signetics' revenue picture is not a pretty one. Last year's revenue of $562 million is more than $150 million short of the company's peak of $720 million in 1984.

"The position of Signetics in the market today can be, has to be, improved," declares Heinz Hagmeister, Philips Components IC business unit managing director, based in Eindhoven, The Netherlands.

"No. 20 in the world is not exactly a leadership posi-

Leaders in the U.S. semiconductor market



tion," acknowledges Siemens' Horstman, of his company's rank. And he is right. Siemens' U.S. integrated circuit sales, after more than 10 years of trying to penetrate this market, are not yet $100 million, according to analysts' estimates. The company acknowledges that its U.S. market share is still less than 1%. Siemens did, however, show a 17% U.S. growth in 1988 over 1987, according to Dataquest, but that percentage still leaves it underperforming the U.S. market as a whole; the U.S. market grew at 25% last year. Siemens' total IC revenue worldwide last year was $440 million.

SGS-Thomson actually gained U.S. share last year — it now has 3%, according to the company — giving it the distinction of being the only European company to do so. The Franco-Italian company, with European headquarters in Agrate, Italy, and Paris, also recorded a 40% sales increase in 1988 over 1987, according to Dataquest. But SGS-Thomson has to live with the fruits of its lost opportunity in DRAMs. The Thomson-Mostek merger gave the company both patents and a DRAM-capable fab, but reluctance on management's part has put it in the position of having to now "creep back into the DRAM market," says the company's Phoenix, Arizona-based U.S. president Daniel Queyssac.

America or bust

Based on U.S. market numbers, it is obvious that European companies had to change their ways. Historically weak in marketing, sales presence and technology, the Europeans, their new structures now in place, are giving it their all. For some firms, this new emphasis has been easier than for others.

"The biggest increase in our sales today is coming from America," says SGS-Thomson's corporate vice president for marketing Philippe Geyres. But Geyres, based in Paris, says SGS-Thomson is not satisfied with its 3% share of the U.S. market, particularly if it is going to meet its goal to be a top 10 semiconductor player worldwide. "We want to have 5% of the U.S. market," he declares. "That is the minimum we need to be a world class player."

To get there, SGS-Thomson, which employs an 1,800-person staff in the United States, has asked its stockholders to accept minimal profit over the next few years, Geyres says. That

Highlights of top European companies' U.S. semiconductor sales

N.V. Philips*

Total U.S. semiconductor sales ($ millions)

Leading products: 1988 U.S. sales ($ millions)

- **Bipolar standard logic:** $124
- **Analog:** $68
- **Microcomponents:** $39
- **Bipolar ASICs:** $29
- **MOS memories:** $16
- **MOS ASICs:** $4

* Includes Signetics Corp.

Notes: MOS memories figure represents primarily nonvolatile memories. Philips/Signetics had no SRAM revenue from the U.S. in 1988, and only $2 million from SRAMs worldwide.

SGS-Thomson

Total U.S. semiconductor sales ($ millions)

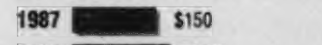
Leading products: 1988 U.S. sales ($ millions)

- **Analog:** $59
- **Nonvolatile memories:** $35
- **Microcomponents:** $30
- **SRAMs:** $24
- **MOS ASICs:** $20

Notes: The SGS-Thomson figure for microcomponents represents almost $15 million in microcontrollers alone: These figures also do not include recent acquisition Inmos Ltd., which would add another $62 million to SGS-Thomson's U.S. sales in 1988.

Siemens AG

Total U.S. semiconductor sales ($ millions)



Leading products: 1988 U.S. sales ($ millions)

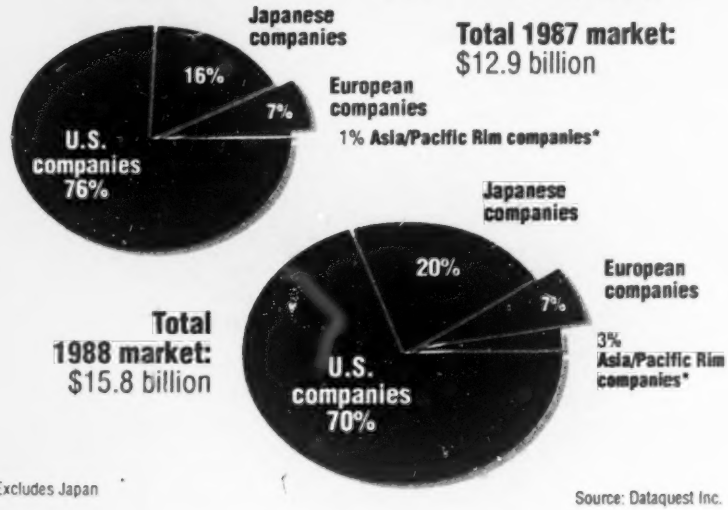
- **Discretes:** $54
- **ASICs:** $10
- **Microprocessors:** $10
- **DRAMs:** $9
- **Bipolar:** $3

Notes: The majority of Siemens' sales in the U.S. were in MOS, representing $68 million of the total figure.

Source: Dataquest UK Ltd.

Foreigners' shares of U.S. semiconductor market

Share of the North American semiconductor market by company origin



* Excludes Japan

Source: Dataquest Inc.

way, cash will be available for expansion in the United States and Japan.

That expansion has already begun. Capacity at the company's Carrollton, Texas, fab facility has more than doubled over the past year, and the U.S. salesforce has been beefed up. Additionally, more U.S. design centers are being added to support SGS-Thomson's latest acquisition, the Transputer from Britain's Inmos Ltd., again with an eye toward increasing profits. Inmos is once again ramping up its SRAM business to work in conjunction with SGS-Thomson, and Geyres says he has high hopes for their prospects in SRAMs.

But DRAMs are a different story. U.S. president Queyssac says the company must be in the DRAM business, but anticipates no headlong rush. Rather, SGS-Thomson will go slowly, and produce products as it can support them. At the very least, however, SGS-Thomson will now be able to add Inmos' U.S. revenue to its own, bringing the company closer to that critical mass of $1 billion that Geyres, Queyssac, and chairman Pasquale Pistorio are so adamant about.

While SGS-Thomson is empire building, Philips/Signetics is in a salvage mode. Philips and Signetics have reorganized, creating a structure that will "hopefully allow us to streamline our operations, and make sure we are in areas where we can win," says Dykes. Hagmeister adds: "We had to restructure. We were not getting out of this business what we wanted. We were not moving forward."

Dykes and Hagmeister, both new to their positions, presumably are part of the restructuring — aimed at restoring Philips to glory. Part of restoring Philips will mean the eventual demise of "Signetics" as a name brand. Although neither Hagmeister nor Dykes will say just when the Signetics name will be replaced by Philips Components, it does not seem likely before some time next year.

So now the company is divided along product lines, with corporate headquarters in The Netherlands retaining responsibility for four product areas, and the U.S. operation for three. Dykes explains: "It just makes sense to put product development and R&D where it can best be used. I don't have any business doing research on new standard logic products, but I should be developing new

Takeover mania leaves Plessey dangling

Plessey Semiconductor Ltd. is having a tough time right now — and not just in the United States.

Caught up in merger/acquisition mania, The Plessey Company Plc has spent the long summer waiting to see whether Britain's General Electric Co. and Siemens AG will succeed in a bid to acquire it. GEC and Siemens each hope to acquire 50% of the British conglomerate.

Informed speculation from analysts and other inside sources does give GEC and Siemens the likelihood of succeeding in the takeover bid next month, leaving Plessey's chip group in a precarious position.

Published reports in Britain have said Doug Dunn, the semiconductor managing director, and his management team intend to lead a buyout of the chip operation from GEC/Siemens if the takeover succeeds; those same published reports indicate that GEC and Siemens would be willing to listen to the proposal.

But Dunn is only willing to say that a management buyout would represent "a last ditch stand to retain an independent Plessey Semiconductor, and I have not talked to GEC and Siemens about it."

So right now, Plessey's U.S. plans are somewhat nebulous.

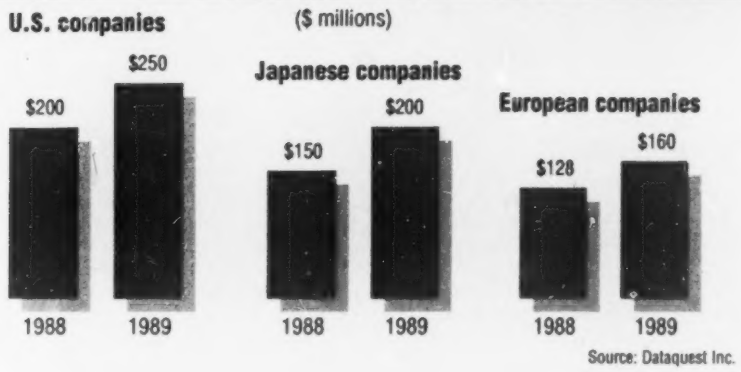
With a manufacturing facility in Scotts Valley, Calif., and $65 million in sales last year, Plessey has slowly begun to penetrate the U.S. market. Dunn has put more people in sales in the U.S. over the last year than ever before. They have, in the words of U.S. marketing director Philip Pollock, "established a beachhead."

But for Dunn, it is not enough. "We need to get to a critical mass of around $200 million," he stresses. "It is not enough to be seen as a persistent visitor. We must be a resident."

To become a resident, Plessey intends to expand its product line, "not deepen it," Dunn says, and leverage its strengths as a broadline ASIC supplier in both CMOS and bipolar. The key will be a relationship with another U.S. supplier.

Dunn is optimistic for the future. "We spend like an American company in terms of R&D and sales and marketing and we don't need to be like a TI or a Motorola. The U.S. market is open and receptive to British technology. The Americans just need to commit to one or two suppliers and stick with them. That's all we need." □

Semiconductor capital spending in the U.S.



Source: Dataquest Inc.

programmable logic devices."

A telling sidelight to this strategy: under the restructuring, the beleagured SRAM product line — which has yet to yield any U.S. product — will report directly to Hagmeister, a sign, certainly, of its importance to the company.

"We can't continue at the rate we were going," Dykes stresses. Now the company, which has reduced its workforce over the last few years to 8,500, plans to play to its strengths in the EDP and automotive markets — particularly automotive — where Signetics has lost ground of late, Dykes says.

For Siemens, the vehicle to success in America may lie in partnering, which all three European concerns are doing to some degree. Siemens alone has agreements with Intel Corp.; Mips Computer Systems Inc.; Toshiba Ltd.; and Advanced Micro Devices Inc., which Siemens also owns a piece of.

Philips has arrangements with Motorola Inc. and VLSI Technology Inc., as well as an as-yet-unnamed microprocessor supplier. SGS-Thomson has a relationship with National Semiconductor Corp., and appears to be shopping for a microprocessor relationship as well, and maybe a DRAM partner or two.

Behind every one of these relationships is a desire by the Europeans to offer a broad category of parts to customers. "The biggest challenge in the American market is having a broad catalog of products," says Hagmeister. "It is a minimum to compete to have a broad line of products. There are vendor reductions going on. You have to have a broad range."

For Siemens in particular, which hopes to attract big U.S. multinationals as customers, this broad category of products is vital. "When you have the central processor in a system, it opens you up to selling all the things that go around it," says Iselin, New Jersey-based Siemens Components president and CEO Wilfried Backes of the company's plans to offer the Mips processor. So when Siemens wants to sell to its customer Digital Equipment Corp., it can do so with a broad catalog, and offer the added bonus of supplying DEC around the world, says Backes.

But for now, Siemens hopes this strategy of appealing to internationally minded companies will help offset its lack of a wafer fab in the United States.

Must market or die

Despite all of these lofty plans in place, the Europeans still must live down their reputations as "marketing-adverse" companies.

"We don't see their salesforce at all," says Hewlett-Packard Co.'s director of corporate purchasing Gene Richter. "They don't have a big engineering or technical market presence. They are doing something about that now, but it looks like [in the past] they haven't tried that hard here. There hasn't been a lot of concentration on this market."

"There was no clear identity in the past as to what their product strategies were," adds Dataquest's de Dios.

This lack of focus, combined with

Who will "Europeanize" the U.S.? The winner is . . .

With the battle lines drawn, and the sides chosen, it is difficult to determine which European chip company is likely to come out on top in the battle to "Europeanize" the United States.

N.V. Philips GL, SGS-Thomson Microelectronics and Siemens AG all offer some rather potent strengths and weaknesses.

And although an informal ELECTRONIC BUSINESS poll of the "most likely to succeed" was split between SGS-Thomson and Siemens, one element is clear: He who wins must have memories and microprocessors.

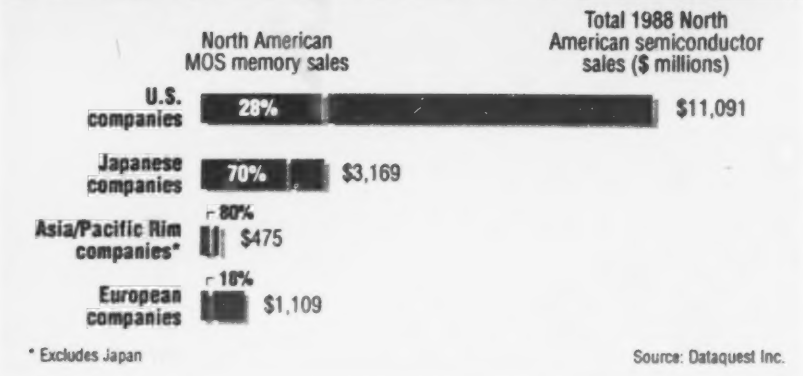
To date, the Europeans have had almost no presence in the two fastest growing markets — 32-bit microprocessors and memories. Siemens, for example, has been selling 1Mb DRAMs for more than a year, but says the products represent less than 5% of total 1988 sales. Numbers from market research company Dataquest Inc. show that Siemens sold only $9 million worth of DRAMs in the U.S. last year, a small number for a year when the market was in shortage. But undoubtedly Siemens is a motivated DRAM supplier. Company executives estimate almost $500 million was spent on acquiring the technology and putting the fab facility in place.

Philips, meanwhile, after investing hundreds of millions of dollars in SRAMs in the MEGA Project with Siemens, has yet to ship any static RAMs in the United States at all. Although Signetics Corp. president James Dykes is optimistic about his future in the SRAM business, he is concerned: "We have not abandoned the SRAM market. There are a lot of marbles bet on that piece. It's not too late if we can execute." Signetics should start shipping its SRAMs in the fourth quarter of 1989, Dykes says.

SGS-Thomson has only a minor presence in SRAMs ($24 million in the United States last year), but that is an area targeted for increased growth in the years to come, says United States-based president Daniel Queyssac.

Neither Philips nor SGS-Thomson have any kind of significant presence in the 32-bit microprocessor market. Philips is expected to sign a second-source agreement with

U.S. MOS memory market breakdown



sporadic marketing efforts in the past has harmed European reputations. Signetics, in particular, has suffered, Dykes says. "After the acquisition by Philips, there was a long period of waiting here, waiting to see what the change in strategy would be." When that happened, development still continued, but the company's presence in Silicon Valley wavered. Now, Dykes says, the time has come to refocus and restructure.

Customers, however, remain leery of the Europeans' new attention to marketing. Siemens, one major DRAM workstation customer says, is now "taking steps in the right direction." Nonetheless, that same customer questions whether Siemens has the business plan, self confidence or organizational structure to "really take on the U.S. marketplace."

Such an attitude among customers that they are poor marketers is not all the Europeans must contend with. The biggest hurdle to overcome in the United States is a perceived lack of technology. "I don't see them as state of the art," contends one purchasing manager of a large U.S. computer company. "The Europeans are not driving the technology."

From weak product lines, to nonexistent or substandard manufacturing, to out-of-date products, the Europeans have trailed both the Americans and Japanese in the race for technology leadership. And it is more than just the fact that the Europeans are weak in memories and microprocessors. It is that they have not viewed the markets and the customers the same way as the Americans, and that they are not structured to exploit opportunities.

In the two key ways to judge technology leadership — capital spending and research and development dollars — the Europeans lag behind both the Americans and the Japanese.

In terms of capital expenditures, the Europeans dramatically underspend both U.S. and Japanese companies, both in the United States and worldwide. According to Dataquest, Europeans spent $128 million on capital equipment in the United States last year, while Japanese companies spent more than $150 million and American companies spent more than $200 million. Worldwide, European capital spending accounted for well less than 10% of the $10 billion total last year. In fact, the Europeans spent only $788 million on capital equipment worldwide last year.

Next year, European companies are expected to spend about $160 million, while the Japanese will spend well in excess of $200 million in the United States. Europe's kind of capital spending commitment does not make for technology leadership, semiconductor market analysts agree.

In terms of manufacturing presence, the Europeans look weak in comparison with others. Signetics, for example, has five fabs in the United States, but only three are state of the art, 1.5 micron or better. The Japanese, on the other hand, have no fabs in the United States over 1.5 micron, and companies such as NEC Corp. are expanding their existing fabs. Siemens does not have a U.S. manufacturing presence at all, al-

a 32-bit vendor; the most likely candidate is speculated to be Motorola Inc. SGS-Thomson is fielding Inmos Ltd.'s Transputer, but as corporate marketing vice president Philippe Geyres readily admits, it is somewhat of a niche product.

Siemens is the only one of the three to offer a reasonable 32-bit candidate — in the shape of Mips Computer Systems Inc.'s 3000 microprocessor.

But disregarding, for the moment, products, the intangibles enter into the decision — such as personality. Those favoring SGS-Thomson to "Europeanize" the United States (and they include customers, some analysts and some European companies) give colorful and charismatic chairman Pasquale Pistorio the edge hands down.

"Pistorio will brute force that company to the top," says one analyst. "I would give SGS-Thomson the nod just on the strength of his personality."

"Pistorio is the one person who really seems to know what he is doing in the marketplace with the marketing," says Integrated Circuit Engineering Inc. analyst William J. McLean.

And purely from a numbers perspective, SGS-Thomson is a safe bet. The only company to increase its market share in 1988, SGS-Thomson is executing on its strategy. The company, however, is in the weakest product position, with no mainstream DRAM or 32-bit technology to field.

The other strong candidate is Siemens. "Siemens is giving us high quality 1Mb DRAMs today," according to Sun Microsystems Inc.'s purchasing manager Scott Metcalfe. "They are right up there with the Japanese."

And certainly in terms of technology, Siemens appears to be in a strong position, with both DRAMs and the Mips processor as aces in the hole. A lack of U.S. manufacturing is a downside, however, and some customers feel that the company lacks "presence."

Siemens Components' CEO Wilfried Backes agrees. "Siemens is not a household word here," he quotes. "That is one of the things that really holds us back." Nonetheless, several analysts and Siemens customers would give them the vote in the battle for the New World. Says one customer: "I'd give it to Siemens. They've proven they can do DRAMs in high volumes. That's a big step." □

though the company is still debating the wisdom of putting a quick-turn ASIC fab in its Santa Clara, Calif., headquarters.

And perhaps most revealing of all, the Europeans have not kept the pace in research and development spending in the past. European R&D spending is on the whole lower than the U.S. average of 18%, ranging from 8% at SGS-Thomson to a high of 15% at Signetics. Siemens spends 9% per year of U.S. sales on R&D, but all these companies are outspent by most American competitors since the U.S. firms are so much larger.

Techno-lag

How far do Europeans really lag behind the Americans and Japanese? SGS-Thomson's Geyres flatly states: "There is no lag. We have the submicron fabs, we have the processes. There is no lag." However, analysts' estimates range from a six-month lag to almost two years. Certainly, the Europeans were not first with either 32-bit processors or 1Mb DRAMs, one technology indicator.

And European companies are not developing the technology on their own, as shown by Siemens, which was forced to resort to licensing its DRAM technology from Toshiba Corp. This happened as well with some of its gate array and standard cell technology.

The Europeans are not quick to move on new processes either. Right now, some European companies are suffering for their slow move into CMOS, and companies such as Philips/Signetics are "still primarily a bipolar house," admits Dykes.

This hurts the Europeans in two ways. First, it limits their ability to go after high-growth markets, like ASICs, says LSI Logic Inc. president George Wells. "The Europeans aren't strong in CMOS, and they have lagged in ASICs, probably because they have such a strong bent toward bipolar. We don't see them as competition at all." Secondly, it traps them into such high-volume, low-price commodity businesses as standard logic. "There is a $500 million dead weight there [at Philips] in standard logic," notes Integrated Circuit Engineering Inc.'s market research manager William J. McLean.

The Europeans are being outpaced by the upstart Koreans

This situation is endemic to the Europeans, critics say: great R&D, but poor implementation. "I am convinced those companies have the technology in the bowels of their operations," McLean states. "But you just don't see it get out."

And in some cases, you just don't see it. Siemens, for example, developed its own 32-bit RISC processor, but decided that "we just couldn't market it with any success, even in Europe," components executive Horstman admits. So the company cut a deal with Mips of Sunnyvale, Calif., for its 3000 processor.

"There never has been in Europe the same entrepreneurial environment we have had here," Signetics' Dykes explains. "A lot of the advancement in the U.S. market has been a result of entrepreneurial activities."

"The Europeans don't have productive product development machinery yet," adds Intel Corp. executive vice president and general manager David House. "They haven't developed the Silicon Valley spirit. They are not nimble on their feet. I've watched the Europeans try and take on the U.S. market before. There is nothing new in this. Ninety percent of our [competitive] problems come from across the other ocean."

The other big disadvantage for the Europeans is the small size of their computer industry — approximately one half the size of the U.S. systems market of $64.3 billion in 1988. While computers are a driving technology force in the United States — the largest single semiconductor market outside of the military — in Europe, telecommunications is a bigger market and tends to be the prime technology driver. Thus, European companies in the United States are often unprepared for the kind of technology demands placed on them.

Despite all these obstacles, it is clear that the Europeans must make a dent in the U.S. market now. If not, they will have lost forever the opportunity to call themselves "global."

"You can't ignore America if you are a large chip supplier," SGS-Thomson's Geyres says, reflecting a sentiment all the Europeans share. "We will do whatever we have to do. We will be cautious."

But he is optimistic, too. Speaking about such companies as Texas Instruments Inc. and Motorola Inc., both of which have successful European operations, Geyres finds hope. "We are more American than they are European," he says. "We can do it, too." □

Siemens vs. NEC: Gauging U.S. success

One way to judge just how well the Europeans have executed in the United States is to compare them with, say, the Japanese.

With language and cultural barriers far greater than those of the Europeans, the Japanese should be hampered in their drive on the U.S. market. However, Dataquest Inc. market share data gives the Japanese 20% of the U.S. market, while the Europeans are staying steady at 7%.

According to analysts, the two best comparisons can be made between NEC Corp. and Siemens AG.

"Siemens is not like NEC," disagrees Integrated Circuit Engineering Inc.'s William J. McLean. "They don't have enough emphasis on top on semiconductors. There is a big difference between the two."

But is there?

Both companies started "seriously" selling ICs in the United States in the early 1980s. NEC's U.S. sales represent 10% of its total revenue, while Siemens, by its own admission, attributes less than 1% of its worldwide sales to the United States.

NEC has one Class 10 fab in Roseville, Calif.; Siemens has no manufacturing capacity to date. NEC also recently announced it is doubling the size of its Roseville plant. □

"Do or die" time confronts Schlumberger

Behind the leadership of test veteran Irwin Pfister, this former ATE titan aims to restore customer confidence — and slipping market share

BY TONY GREENE

Sharper focus. That's the key to the new strategy of once-dominant Schlumberger Technologies ATE division — brought to bear through one executive, Irwin H. Pfister, now three years as vice president/general manager of the Schlumberger Ltd. unit.

Balancing on the edge of his chair, Pfister waves his hands vigorously in the air to emphasize his point. "Three years ago when Schlumberger gave me this job, my mission was to pump air into the body. I didn't realize the body wasn't breathing," Pfister says in his characteristically direct manner. "We were overstaffed, we had no new product, we weren't visiting our customers, we had three manufacturing sites, and we had three development sites. Do you need anything else!"

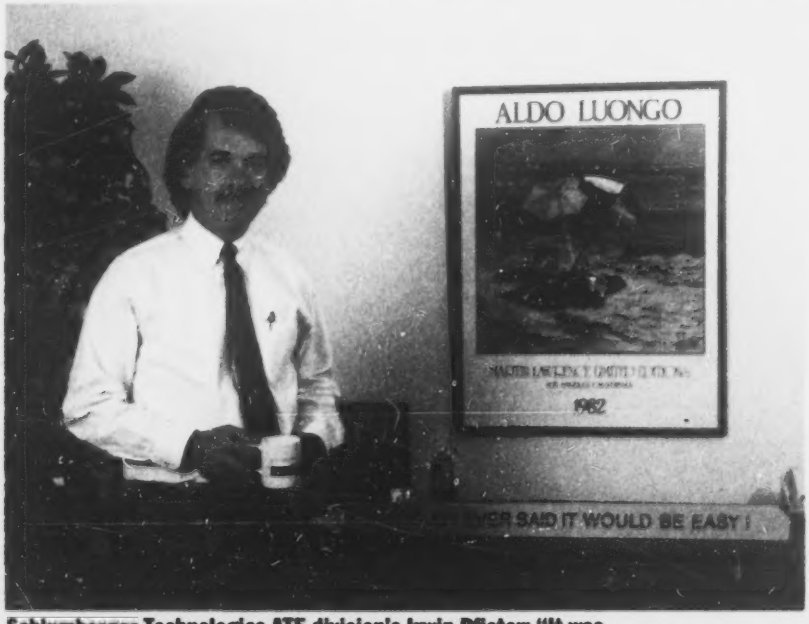
That desire for focus drives Pfister; he prefers giving an interview in the peace of his hotel room because he finds restaurants too distracting, and "you can't get any business done."

With 13 years of management experience in the electronics industry before coming to Schlumberger, Pfister brought to the company a severely needed understanding of the ATE business; most recently he served as vice president for marketing, vice president for engineering, and general manager of ATE vendor Computer Automation Inc.'s industrial products division. "I've been in the service business my entire career," he says. "Schlumberger was in the test equipment business. They were just taking orders and shipping goods."

Now, San Jose-based Schlumberger ATE is focusing on "bringing hardware and software solutions to engineering problems." But to do so it must maintain its dwindling market share and improve the quality of its products and service while still bringing new product to the market.

It is a focus Schlumberger needs. In May 1986, Pfister was handed the reins of a company that at one time dominated its industry. When the ATE market peaked at $1.8 billion in 1984 and 1985, a level it did not reach again until 1988, when it passed $2.1 billion, Schlumberger had a 17% share with revenue of $311 million. That percentage has since slipped, reaching its lowest point in 1988 when Schlumberger had a 10% share with revenue of $220 million.

The downturn in Schlumberger ATE's fortunes was painfully apparent to the company when Pfister came aboard. Schlumberger was seeing a massive defection of its customer base as products such as the Sentry 50 IC tester were late to market and did not meet customer requirements. Customers were unable to get the fault coverage and throughput they needed. In the cutthroat ATE world, competitors, such as Boston-based Teradyne Inc. and LTX Corp. of Westwood, Mass., were quick to move in and carve up the available market share. "It was obvious we weren't listening to or talking to our customers," says Pfister.



Linda Sue Scott

Schlumberger Technologies ATE division's Irwin Pfister: "It was obvious we weren't listening to or talking to our customers"

Alienated customers

Schlumberger alienated customers who spent millions of dollars on its ATE equipment and software by telling them they needed new testers and software that were incompatible with existing Schlumberger systems. Customers were also told they would have to wait for the systems. "We

went away from Schlumberger in 1984-1985 because of their lack of willingness to work with customers. They were arrogant," says L.J. Reed, vice president and general manager of Motorola Inc.'s ASICs division.

Motorola needed to stay with Schlumberger and the Sentry 50 because the investment Motorola made in software development began a year before the first system was to be delivered. "The machine had technical problems, and they couldn't deliver it," says Reed. "Schlumberger's attitude was, 'Yes, I'm late and you're going to have to wait.' We didn't see the kind of urgency that should have been there." Reed says Motorola could not ship product because the tester had not arrived. Ultimately, an estranged Motorola quit Schlumberger and bought LTX testers.

While some observers attribute Schlumberger's decline in the ATE arena solely to its market blunders, others say the problems ran deeper. "Schlumberger didn't understand the ATE industry," says industry analyst Kenneth Neff of the San Jose market research firm Prime Data.

Industry watchers say Schlumberger, incorporated in the Netherlands Antilles, did not understand the electronics industry in general. They point to the 1987 sale of Fairchild Semiconductor at a loss of $220 million as an admission of defeat in the highly competitive semiconductor market. The fact that Schlumberger's ATE operation has borne four names in the last 10 years — from Fairchild ATE in the early 1980s to Schlumberger Technologies ATE division today — has left an already jittery customer base that is confused and concerned about the company's commitment to ATE. Pfister has a straightforward reply to alleviate these problems: "The recipe [to fix it] is simple. You make a commitment to your customer and you fulfill it, and you go back and make another commitment and do it again."

Quick to take concrete action to eradicate customers' confusion over the name changes, Pfister is replacing the nameplates. "We're going to have a conscious effort with each sales guy. He is going to go out and take the old name plate and replace it with one that says Schlumberger Technologies," says Pfister.

Improved employee training

This kind of decisive action is indicative of the strategy guiding Schlumberger Technologies' ATE. Since taking over, Pfister has cut the 2,000 employee domestic staff in half. Schlumberger also has closed all three of its original manufacturing facilities to build one highly automated, quality-intensive facility in Simi Valley, Calif. In addition, research and development was concentrated in one facility in San Jose.

Pfister brought to the company a severely needed understanding of the ATE business

Having set quality in product, service and support as a linchpin to its strategy, Schlumberger ATE is seeking to give its employees the skills needed to carry it out. "The key is training and educating the people. We teach them how to identify a problem and give them the tools to deal with it," says Pfister. Schlumberger ATE allocates 20% of each employee's time during the first six to nine months of hire to quality training using an interactive 161-page training manual. After the initial period, each employee spends about two hours a week on quality issues.

"When I first came in here," Pfister says, "[employees] believed if you didn't have the latest, greatest product, the customer didn't want to see you. Today, I think the organization believes in more than product. They do what the customer needs them to do."

Customers that were once critical of Schlumberger are beginning to see the change. "I really believe that you can use Schlumberger's ATE group as a model of what needs to be done in this country," Motorola's Reed says now. "Their attitude is to give the customer what they want, not what [Schlumberger] has." In May, Motorola awarded Schlumberger $8 million as part of a joint development program for a new type of high-speed high-pincount ATE machine.

Yet, despite Motorola's affirmation of Schlumberger ATE, the battle for Schlumberger to regain market share and revenue continues. "For us right now, Trillium, [LTX] and Teradyne are the companies we focus on. Schlumberger would be a second tier consideration," says Howard High, strategic communications manager for Intel Corp.

One way to get out of the second tier is with new products. Schlumberger is introducting five new product families this year, ranging in price from $200,000 to $1.4 million. "It is do or die on these new products," says Shearson Lehman Hutton Inc. analyst Steven Balog. Pfister says Schlumberger is primed to meet such a challenge: "The business is a hell of a lot healthier than it was three years ago."

"Schlumberger has an advantage. Even though they are huge in the market, they are kind of sneaking in. It seems that the competition is not concerned about them," says Hambrecht & Quist analyst Carolyn Rogers. That is an attitude that Schlumberger has already learned is dangerous to have. □

Schlumberger's ATE market share

* Does not include Schlumberger's revenue from its IDS 5000 E-beam prober

Source: Prime Data

Top 100 R&D spenders increase investment by 15.7%

Exclusive ELECTRONIC BUSINESS ranking reveals a collective $18.2 billion spent on R&D by the top 100 in 1988. Software firms post the highest rates

There were no great surprises on the ELECTRONIC BUSINESS 1988 list of the top 100 research and development spenders in the electronics industry. Total R&D spending saw a double-digit percentage increase in 1988 over 1987, while R&D spending as a percentage of sales rose nominally. Software companies posted the highest rates of R&D spending, with four firms making the top 10, up from two last year.

Combined, the top 100 companies spent $18.2 billion on R&D in 1988, a 15.7% increase from the $15.7 billion logged in 1987. That mirrors a rise in sales for the same 100 companies of 15.4%, from $182.1 billion in 1987 to $210 billion in 1988. In the key category of R&D spending as a percentage of sales, the figure for the top 100 electronics companies rose from 8.6% in 1987 to 8.7% last year.

BY BRUCE C.P. RAYNER and LINDA STALLMANN

The top 100 R&D spenders is an exclusive ranking compiled by ELECTRONIC BUSINESS from United States-based publicly held companies in the electronics industry. To qualify, a company must derive at least 70% of its sales from electronics and be listed in the ELECTRONIC BUSINESS 200 [ELECTRONIC BUSINESS, July 24, 1989].

There were some companies that rose in the ranks and some that fell. Management Science America Inc., ranked No. 2, is making its first appearance this year. Dropping precipitously were Applied Materials Inc., down to No. 21 from No. 4 last year, and Intel Corp., which fell to the No. 31 spot from No. 11 in 1987.

But despite the usual ups and downs, there is some cause for concern with the underlying fundamentals of the top R&D performers in 1988. Cullinet Software Inc. is the top-ranked R&D spender for the second consecutive year. A developer of IBM mainframe software, Cullinet spent a robust 24.2% of its $217 million in sales on new product development. But the company's heavy R&D spending contributed to two years of red ink on its bottom line.

(Cullinet will never appear in our ranking again. It was bought in June by 25th-ranked Computer Associates International, also an IBM mainframe software company, for an estimated $320 million.)

Even meteoric Management Science America, a major software company, has its share of problems. MSA scrambled to reposition itself in the world of IBM's new Systems Application Architecture by spending heavily on product development last year. As a result, it reported losses of $33.6 million in its latest fiscal year ended December 1988.

Likewise, fourth-ranked automated test equipment maker LTX Corp. has been unprofitable in the first half of its 1989 fiscal year. And Cray Research Inc., ranked seventh, is restructuring and scaling down some of its R&D effort.

Is the combination of poor performance and high R&D spending a trend? Probably not. Sound financial health and high R&D spending do not necessarily go hand in hand. Indeed, good performance can lead to *lower* R&D spending. At least that is what happened at Advanced Micro Devices Inc.

Top-ranked in our R&D listing in 1986, AMD dropped to third place this year, spending about 18.5% of its sales on R&D, down from 30% two years earlier. The reason is threefold, according to a company official: the merger with Monolithic Memo-

Top U.S. R&D spenders

Rank 1988	Rank 1987	Company	R&D as a percentage of revenue	Total R&D expenditures ($ millions)	Industry segment
1	1	Cullinet Software	24.2%	$52.4	Software
2	—	Management Science America	23.6%	58.9	Software
3	2	Advanced Micro Devices	18.5%	208.3	Semiconductors
4	3	LTX	18.1%	31.6	Capital equipment
5	8	Lotus Development	17.9%	83.8	Software
6	37	Ashton-Tate	17.2%	52.9	Software
7	6	Cray Research	15.6%	117.8	Mainframes
8	—	Integrated Device Technology	15.5%	18.8	Semiconductors
9	9	Tektronix	15.3%	215.6	Capital equipment
10	12	GenRad	14.9%	30.7	Capital equipment
11	7	Analog Devices	13.8%	60.5	Semiconductors
12	5	Teradyne	13.4%	61.9	Capital equipment
13	15	Sun Microsystems	13.3%	139.9	Minicomputers
14	13	DSC Communications	13.2%	45.0	Communications
15	—	Chips & Technologies	13.2%	18.7	Semiconductors

Fiscal 1988 figures

Source: ELECTRONIC BUSINESS

Top U.S. R&D spenders

Total R&D spending
($ millions)

IBM	$5,925
Digital Equipment	1,307
Hewlett-Packard	1,019
Xerox	794
Unisys	713
Motorola	665
GM Hughes Electronics	551
Texas Instruments	494
NCR	416
Control Data	336
Honeywell	323
Intel	318
National Semiconductor	280
Apple Computer	273
Wang Laboratories	246

R&D spending per employee

Chips & Technologies	$60,828
Ashton-Tate	42,290
Lotus Development	33,535
Amdahl	26,626
Apple Computer	25,233
Microsoft	24,982
MSA	24,874
Applied Materials	24,633
Quantum	23,754
Cray Research	22,485
LTX	22,376
Cullinet Software	21,830
Mentor Graphics	19,786
Sun Microsystems	19,733
Tandem Computers	19,638

R&D spending growth
Percentage change from 1987

Oracle Systems	226.4%
Chips & Technologies	167.3%
Conner Peripherals	144.0%
Computer Associates	103.2%
Sun Microsystems	101.1%
Loral	100.7%
Maxtor	90.4%
Ashton-Tate	88.9%
Everex Systems	86.4%
Microsoft	83.3%
Western Digital	81.1%
Wyse Technology	74.3%
3Com	69.8%
Stratus Computer	61.6%
Novell	60.5%

Fiscal 1988 figures

Source: ELECTRONIC BUSINESS

ries Inc. in 1987 resulted in R&D redundancies and better leverage from R&D spending; leverage has also improved from the $10 million annual R&D contribution AMD makes to semiconductor consortium Sematech; and collaborative ventures with the likes of Sony Corp. and Siemens AG mean less R&D in-house. AMD's R&D spending will stay between 15% and 20% over the long-term, the official adds.

AMD is way ahead of the competition in the semiconductor industry when it comes to R&D spending as a percentage of sales. The industry average is 9.4%. But in dollar terms, Motorola Inc., the largest U.S. chip maker, outspent them all with $665 million in 1988, up from $524 million in 1987.

While Motorola's R&D investment is significant, it is dwarfed by IBM's budget. IBM spent only 10% of sales for R&D, but that represents $5.925 billion. Big Blue alone accounts for 32.6% of the total R&D spending by the ELECTRONIC BUSINESS 100 top R&D spenders, outdistancing Digital Equipment Corp., its closest R&D rival by more than four times.

Oracle Systems Corp., a database management software company, might not be an IBM, but it tops the fastest growing list with a whopping 226.4% growth in 1988 spending over 1987. This is almost double the growth of Genicom Corp., the fastest growth leader in 1987, which posted a growth rate of 143.3%.

But Oracle's R&D growth is somewhat overstated. According to company financial statements, 1987's R&D spending was adjusted downward due to an accounting change in the capitalization of software development costs, thus making the growth rate between the two years higher. Nonetheless, the increase is still impressive. The company spent

Software companies posted the highest rates of R&D spending with four firms making the top 10

$7.48 million or 13.5% of its sales on R&D in 1986, $9.95 million in 1987, and $25.7 million in 1988.

Is U.S. spending sufficient?

Is the U.S. electronics industry spending enough on research and development? The answer is uncertain, because up-to-date comparative figures are hard to come by. The U.S. electronics industry as a whole spent an estimated $60 billion in 1988 on R&D, of which about $33 billion was spent by the high-technology sector, excluding chemicals, according to the National Science Foundation (NSF). The ELECTRONIC BUSINESS top 100 accounts for about 55% of the industry's total.

Comparatively, U.S. industry spends more on R&D than Japan, France, Britain and Germany combined, says Carlos Kruytbosch, director for scientific indicators at the NSF. But in terms of a percentage of Gross National Product, the United States is running fairly evenly with all four. In fact, Kruytbosch says, U.S. industry's spending as a percentage of GNP is declining every year, while the same figure for the major trading partners is increasing.

But total dollar spending is not necessarily the critical issue, says Martyn Roetter, manager of information industry service at the consulting firm of Arthur D. Little Inc. "It is not so much whether or not the absolute level of R&D is right but whether those resources are being applied correctly," he says.

Improving efficiency of R&D funds includes speeding up development time and adopting some of Japan's development methods. That includes integrating manufacturing, design and even marketing into the development phase of the product. Roetter says one of the key issues with high-tech companies today is how they can improve the productivity of R&D funds. □

Top U.S. R&D spenders

Rank 1988	Rank 1987	Company	R&D as a percentage of revenue	Total R&D expenditures ($ millions)	Change from 1987	Fiscal 1988 revenue ($ millions)	Change from 1987	Fiscal 1988 net income ($ millions)	Change from 1987	Fiscal year ended
1	1	Cullinet Software	24.2%	$52.4	4.9%	$216.7	23.9%	-$47.0	NM	4/88
2	—	Management Science America	23.6%	58.9	11.8%	250.0	-3.3%	-33.6	NM	12/88
3	2	Advanced Micro Devices	18.5%	208.3	-15.9%	1,125.9	12.9%	19.3	NM	12/88
4	3	LTX	18.1%	31.6	36.3%	174.8	44.9%	7.0	NM	7/88
5	8	Lotus Development	17.9%	83.8	43.5%	468.5	18.4%	58.9	-18.2%	12/88
6	37	Ashton-Tate	17.2%	52.9	88.9%	307.3	14.9%	47.8	10.9%	1/89
7	6	Cray Research	15.6%	117.8	8.2%	756.3	10.0%	156.6	6.5%	12/88
8	—	Integrated Device Technology	15.5%	18.8	32.7%	121.1	55.6%	11.6	351.6%	3/88
9	9	Tektronix	15.3%	215.6	8.0%	1,411.9	1.1%	-16.7	NM	5/88
10	12	GenRad	14.9%	30.7	16.2%	205.9	6.2%	-6.2	NM	12/88
11	7	Analog Devices	13.8%	60.5	8.0%	439.2	18.6%	38.0	103.4%	10/88
12	5	Teradyne	13.4%	61.9	0.7%	462.3	22.4%	-3.3	NM	12/88
13	15	Sun Microsystems	13.3%	139.9	101.1%	1,051.6	95.6%	66.4	83.0%	6/88
14	13	DSC Communications	13.2%	45.0	10.0%	339.7	8.7%	20.0	37.4%	12/88
15	—	Chips & Technologies	13.2%	18.7	167.3%	141.5	76.3%	22.1	71.2%	6/88
16	36	Tandem Computers	12.9%	169.4	56.1%	1,314.7	27.0%	94.5	-10.5%	9/88
17	19	Amdahl	12.3%	221.0	23.5%	1,801.8	19.7%	213.8	50.6%	12/88
18	—	Concurrent Computer	12.2%	32.0	29.4%	263.1	6.2%	14.4	83.0%	6/88
19	17	Data General	12.1%	165.2	3.6%	1,364.7	7.1%	-15.5	NM	9/88
20	16	General DataComm	12.1%	23.3	-8.0%	192.2	-4.2%	-18.4	NM	9/88
21	4	Applied Materials	12.0%	43.5	39.3%	362.8	108.0%	40.0	NM	10/88
22	30	Microsoft	11.8%	69.8	83.3%	590.8	70.8%	123.9	72.4%	6/88
23	28	Apollo Computer	11.8%	76.9	25.9%	653.5	18.0%	0.2	-98.9%	12/88
24	38	Stratus Computer	11.5%	30.6	61.6%	265.3	44.1%	29.3	51.3%	12/88
25	14	Computer Associates	11.5%	81.5	103.2%	709.1	129.3%	101.8	179.0%	3/88
26	33	Digital Equipment	11.4%	1,306.5	29.3%	11,475.5	22.2%	1,305.6	14.8%	6/88
27	20	National Semiconductor	11.3%	280.2	28.0%	2,469.7	32.2%	62.7	NM	5/88
28	21	Digital Communications	11.3%	25.7	21.8%	227.5	25.4%	42.2	56.2%	6/88
29	31	Mentor Graphics	11.2%	33.8	39.8%	300.8	35.6%	33.5	65.0%	12/88
30	34	Intergraph	11.1%	89.2	32.2%	800.2	24.8%	88.0	25.9%	12/88
31	11	Intel	11.1%	318.3	22.5%	2,874.8	50.7%	452.9	158.0%	12/88
32	23	Prime Computer	10.9%	174.3	58.9%	1,594.6	65.9%	13.0	-80.0%	12/88
33	25	Coherent	10.5%	19.7	9.5%	188.1	18.3%	-1.3	NM	9/88
34	32	Fluke	10.4%	23.4	5.5%	224.5	8.8%	12.4	519.4%	9/88
35	27	Hewlett-Packard	10.4%	1,019.0	13.1%	9,831.0	21.5%	816.0	26.7%	10/88
36	42	Westmark International	10.3%	37.8	34.8%	365.3	25.1%	10.4	NM	12/88
37	40	IBM	9.9%	5,925.0	9.0%	59,681.0	10.1%	5,491.0	4.4%	12/88
38	29	LSI Logic	9.8%	37.0	27.8%	378.9	44.5%	23.8	121.9%	12/88
39	44	ADC Telecommunications	9.7%	17.4	12.5%	179.9	7.8%	17.0	11.1%	10/88
40	41	VLSI Technology	9.6%	21.2	26.2%	221.2	28.6%	6.7	-16.8%	12/88
41	26	Cipher Data Products	9.4%	17.4	-13.3%	185.4	4.0%	10.4	141.1%	6/88
42	46	Dynatech	9.4%	34.4	25.9%	367.8	20.7%	24.5	5.6%	3/88
43	50	3Com	9.3%	23.4	69.8%	251.9	128.3%	22.5	102.3%	5/88
44	22	Control Data	9.3%	335.7	-13.7%	3,628.3	7.8%	1.7	-93.2%	12/88
45	75	Oracle Systems	9.1%	25.7	226.4%	282.1	114.9%	42.9	174.5%	5/88
46	67	Maxtor	8.8%	24.0	90.4%	271.2	54.7%	14.1	-36.8%	3/88
47	48	AMP	8.8%	238.0	16.7%	2,699.7	16.5%	319.1	27.8%	12/88
48	55	Western Digital	8.8%	67.7	81.1%	768.3	66.1%	43.0	0.4%	6/88
49	35	Perkin-Elmer	8.5%	98.6	-29.7%	1,165.5	-12.6%	60.0	NM	7/88
50	—	Ask Computer Systems	8.3%	11.9	43.3%	142.4	44.9%	10.8	34.9%	6/88

NM = Not meaningful. The company lost money in the base year

(Continued)

Top U.S. R&D spenders

Rank 1988	Rank 1987	Company	R&D as a percentage of revenue	Total R&D expenditures ($ millions)	Change from 1987	Fiscal 1988 revenue ($ millions)	Change from 1987	Fiscal 1988 net income ($ millions)	Change from 1987	Fiscal year ended
51	—	**Burr-Brown**	8.3%	$14.7	19.1%	$176.7	25.8%	$11.5	169.5%	12/88
52	51	**Medtronic**	8.1%	53.1	26.1%	653.3	30.1%	86.5	17.2%	4/88
53	57	**Motorola**	8.1%	665.0	26.9%	8,250.0	23.0%	445.0	44.5%	12/88
54	59	**Micropolis**	8.0%	28.4	30.5%	353.1	22.5%	-19.4	NM	12/88
55	60	**Wang Laboratories**	8.0%	246.0	15.8%	3,068.4	8.2%	92.7	31.1%	6/88
56	58	**Texas Instruments**	7.8%	494.0	15.4%	6,294.8	12.5%	366.3	42.6%	12/88
57	45	**Applied Magnetics**	7.7%	22.7	16.3%	293.0	38.3%	23.7	66.9%	9/88
58	56	**Storage Technology**	7.7%	67.5	12.3%	874.0	16.5%	44.2	132.8%	12/88
59	68	**Dataproducts**	7.7%	26.7	19.3%	345.2	1.9%	-20.2	NM	3/88
60	62	**Measurex**	7.2%	19.2	14.8%	265.2	16.7%	37.1	38.2%	11/88
61	65	**Diasonics**	7.2%	20.3	9.9%	281.6	5.2%	9.8	-35.9%	12/88
62	73	**Unisys**	7.2%	713.0	19.4%	9,902.0	1.9%	680.6	17.8%	12/88
63	70	**NCR**	7.0%	416.4	16.8%	5,989.9	6.2%	439.3	4.8%	12/88
64	64	**Xerox**	6.9%	794.0	10.0%	11,476.0	11.2%	73.0	-87.4%	12/88
65	53	**Varian Associates**	6.9%	80.2	-0.6%	1,170.6	19.1%	27.8	29.9%	9/88
66	63	**Apple Computer**	6.7%	272.5	42.3%	4,071.4	53.0%	400.3	84.0%	9/88
67	61	**Gerber Scientific**	6.5%	17.1	3.1%	264.0	17.9%	29.6	40.6%	4/88
68	43	**Quantum**	6.4%	12.1	4.9%	188.5	56.1%	-3.2	NM	3/88
69	69	**Watkins-Johnson**	6.3%	18.3	8.0%	292.2	10.6%	20.6	20.3%	12/88
70	96	**Scientific-Atlanta**	5.9%	30.0	49.5%	508.6	2.7%	29.7	22.3%	6/88
71	79	**M/A-COM**	5.9%	25.0	2.2%	424.2	-2.7%	18.4	NM	9/88
72	—	**Everex Systems**	5.9%	15.6	86.4%	266.7	69.4%	10.5	21.8%	7/88
73	49	**TIE/communications**	5.7%	14.6	-32.0%	255.3	2.0%	-17.0	NM	12/88
74	—	**Novell**	5.7%	16.0	60.5%	281.2	53.8%	30.4	49.6%	10/88
75	76	**Cherry Electrical Products**	5.7%	11.0	14.8%	194.6	21.2%	7.4	169.8%	2/88
76	91	**Esterline**	5.7%	16.1	33.0%	284.4	9.5%	8.4	NM	10/88
77	90	**Andrew**	5.6%	14.1	35.7%	253.5	13.6%	13.9	264.5%	9/88
78	77	**Harris**	5.6%	116.9	-0.9%	2,099.3	1.0%	65.4	-22.6%	6/88
79	80	**Molex**	5.3%	26.6	25.8%	502.4	29.9%	59.3	36.5%	6/88
80	83	**Wyse Technology**	5.3%	24.2	74.3%	456.6	75.6%	28.0	54.2%	3/88
81	66	**Aydin**	5.0%	8.5	-15.6%	169.7	13.7%	8.4	-4.9%	12/88
82	87	**Sprague Technologies**	5.0%	25.1	20.7%	504.6	15.4%	13.2	266.7%	12/88
83	99	**GM Hughes Electronics**	4.9%	550.9	32.4%	11,243.6	7.3%	634.6	21.8%	12/88
84	74	**Bolt Beranek and Newman**	4.8%	14.7	2.6%	305.2	30.5%	18.1	NM	6/88
85	—	**Rexon**	4.7%	7.4	49.4%	155.5	53.4%	9.0	44.9%	9/88
86	—	**Atari**	4.7%	21.4	18.4%	452.2	24.7%	39.4	-20.3%	12/88
87	88	**Litton Industries**	4.7%	227.9	8.7%	4,863.9	10.1%	167.0	20.9%	7/88
88	95	**Honeywell**	4.5%	323.4	11.6%	7,148.3	7.0%	-434.9	NM	12/88
89	92	**Loral**	4.5%	64.1	100.7%	1,440.8	108.8%	74.3	29.4%	3/88
90	—	**Tandon**	4.4%	13.7	33.3%	309.3	7.0%	-19.9	NM	12/88
91	84	**International Rectifier**	4.3%	7.7	-4.1%	178.6	17.6%	-12.1	NM	6/88
92	89	**Kollmorgen**	4.2%	14.5	1.9%	344.8	14.5%	14.1	4840.4%	12/88
93	85	**Augat**	4.1%	13.1	-18.6%	321.0	2.5%	-22.8	NM	12/88
94	—	**Seagate Technology**	4.0%	50.1	49.3%	1,257.0	31.2%	77.3	-44.7%	6/88
95	82	**AST Research**	3.8%	15.7	41.2%	412.7	100.4%	15.1	15.6%	6/88
96	94	**Zenith Electronics**	3.7%	100.6	-2.7%	2,685.7	13.7%	5.3	NM	12/88
97	86	**Genicom**	3.6%	10.6	-28.9%	291.4	-3.5%	1.0	-92.0%	12/88
98	100	**Compaq Computer**	3.6%	74.9	58.9%	2,065.6	68.7%	255.2	87.3%	12/88
99	72	**Datapoint**	3.5%	11.6	-39.9%	330.8	6.0%	8.0	NM	7/88
100	—	**Conner Peripherals**	3.4%	8.6	144.0%	256.6	126.6%	19.8	73.8%	12/88

NM = Not meaningful. The company lost money in the base year

(Continued)

Top U.S. R&D spenders by industry segment

Capital equipment

Fiscal 1988 R&D expenditures	Total ($ millions)	As a percentage of revenue	Per employee
Hewlett-Packard	$1,019.0	10.4%	$11,713
Tektronix	215.6	15.3%	13,402
Perkin-Elmer	98.6	8.5%	8,984
Varian Associates	80.2	6.9%	6,798
Teradyne	61.9	13.4%	13,176
Applied Materials	43.5	12.0%	24,633
LTX	31.6	18.1%	22,376
GenRad	30.7	14.9%	15,343
Fluke	23.4	10.4%	9,763
Gerber Scientific	17.1	6.5%	9,262
Esterline	16.1	5.7%	5,328
Segment total	**$1,637.6**		
Weighted averages		**10.5%**	**$11,452**

Communications

Fiscal 1988 R&D expenditures	Total ($ millions)	As a percentage of revenue	Per employee
Motorola	$665.0	8.1%	$6,520
DSC Communications	45.0	13.2%	16,265
Dynatech	34.4	9.4%	11,250
Scientific-Atlanta	30.0	5.9%	8,720
Digital Communications	25.7	11.3%	17,922
3Com	23.4	9.3%	17,372
General DataComm	23.3	12.1%	9,692
ADC Telecommunications	17.4	9.7%	10,358
Novell	16.0	5.7%	10,104
Bolt Beranek and Newman	14.7	4.8%	4,667
TIE/communications	14.6	5.7%	9,721
Andrew	14.1	5.6%	5,274
Datapoint	11.6	3.5%	4,320
Segment total	**$935.2**		
Weighted averages		**8.0%**	**$7,209**

Components

Fiscal 1988 R&D expenditures	Total ($ millions)	As a percentage of revenue	Per employee
AMP	$238.0	8.8%	$9,876
Molex	26.6	5.3%	4,512
Sprague Technologies	25.1	5.0%	3,061
Augat	13.1	4.1%	3,639
Cherry Electrical Products	11.0	5.7%	3,895
Segment total	**$313.9**		
Weighted averages		**7.4%**	**$7,032**

Computer-based systems

Fiscal 1988 R&D expenditures	Total ($ millions)	As a percentage of revenue	Per employee
Hewlett-Packard	$1,019.0	10.4%	$11,713
Intergraph	89.2	11.1%	12,216
Mentor Graphics	33.8	11.2%	19,786
Coherent	19.7	10.5%	11,584
Measurex	19.2	7.2%	7,323
Gerber Scientific	17.1	6.5%	9,262
Ask Computer Systems	11.9	8.3%	17,237
Segment total	**$1,209.9**		
Weighted averages		**10.3%**	**$11,761**

Government

Fiscal 1988 R&D expenditures	Total ($ millions)	As a percentage of revenue	Per employee
Motorola	$665.0	8.1%	$6,520
GM Hughes Electronics	550.9	4.9%	5,679
Texas Instruments	494.0	7.8%	6,527
Honeywell	323.4	4.5%	4,126
Litton Industries	227.9	4.7%	4,144
Harris	116.9	5.6%	5,173
Varian Associates	80.2	6.9%	6,798
Loral	64.1	4.5%	4,680
M/A-COM	25.0	5.9%	3,883
Watkins-Johnson	18.3	6.3%	5,813
Aydin	8.5	5.0%	4,238
Segment total	**$2,574.3**		
Weighted averages		**5.9%**	**$5,503**

Mainframes

Fiscal 1988 R&D expenditures	Total ($ millions)	As a percentage of revenue	Per employee
IBM	$5,925.0	9.9%	$15,306
Unisys	713.0	7.2%	7,667
NCR	416.4	7.0%	6,940
Control Data	335.7	9.3%	10,021
Amdahl	221.0	12.3%	26,626
Cray Research	117.8	15.6%	22,485
Segment total	**$7,728.9**		
Weighted averages		**9.5%**	**$13,163**

Medical

Fiscal 1988 R&D expenditures	Total ($ millions)	As a percentage of revenue	Per employee
Medtronic	$53.1	8.1%	$9,042
Westmark International	37.8	10.3%	11,701
Diasonics	20.3	7.2%	12,243
Segment total	**$111.2**		
Weighted averages		**8.6%**	**$10,333**

(Continued)

Top U.S. R&D spenders by industry segment

Fiscal 1988 R&D expenditures	Total ($ millions)	As a percentage of revenue	Per employee
Microcomputers			
IBM	$5,925.0	9.9%	$15,306
Apple Computer	272.5	6.7%	25,233
Zenith Electronics	100.6	3.7%	2,794
Compaq Computer	74.9	3.6%	10,849
Atari	21.4	4.7%	12,002
AST Research	15.7	3.8%	8,718
Everex Systems	15.6	5.9%	9,759
Tandon	13.7	4.4%	9,263
Segment total	**$6,439.4**		
Weighted averages		**9.2%**	**$14,390**
Minicomputers			
IBM	$5,925.0	9.9%	$15,306
Digital Equipment	1,306.5	11.4%	10,411
Hewlett-Packard	1,019.0	10.4%	11,713
Prime Computer	174.3	10.9%	14,070
Tandem Computers	169.4	12.9%	19,638
Data General	165.2	12.1%	10,712
Sun Microsystems	139.9	13.3%	19,733
Apollo Computer	76.9	11.8%	17,307
Concurrent Computer	32.0	12.2%	9,280
Stratus Computer	30.6	11.5%	17,860
Segment total	**$9,038.7**		
Weighted averages		**10.3%**	**$13,847**
Office equipment			
IBM	$5,925.0	9.9%	$15,306
Xerox	794.0	6.9%	7,930
NCR	416.4	7.0%	6,940
Wang Laboratories	246.0	8.0%	7,961
Harris	116.9	5.6%	5,173
Segment total	**$7,498.3**		
Weighted averages		**9.1%**	**$12,482**
Peripherals			
Storage Technology	$67.5	7.7%	$7,940
Seagate Technology	50.1	4.0%	1,670
Micropolis	28.4	8.0%	8,876

Continued next column

Fiscal 1988 R&D expenditures	Total ($ millions)	As a percentage of revenue	Per employee
Peripherals (continued)			
Dataproducts	$26.7	7.7%	$7,509
Wyse Technology	24.2	5.3%	5,771
Maxtor	24.0	8.8%	7,635
Applied Magnetics	22.7	7.7%	2,401
Cipher Data Products	17.4	9.4%	8,481
AST Research	15.7	3.8%	8,718
Everex Systems	15.6	5.9%	9,759
Quantum	12.1	6.4%	23,754
Genicom	10.6	3.6%	2,875
Rexon	7.4	4.7%	6,308
Segment total	**$322.1**		
Weighted averages		**6.0%**	**$4,423**
Semiconductors			
Motorola	$665.0	8.1%	$6,520
Texas Instruments	494.0	7.8%	6,527
Intel	318.3	11.1%	15,304
National Semiconductor	280.2	11.3%	7,432
Advanced Micro Devices	208.3	18.5%	11,004
Western Digital	67.7	8.8%	10,288
Analog Devices	60.5	13.8%	11,319
LSI Logic	37.0	9.8%	11,448
VLSI Technology	21.2	9.6%	13,006
Integrated Device Technology	18.8	15.5%	14,135
Chips & Technologies	18.7	13.2%	60,828
Burr-Brown.	14.7	8.3%	9,963
International Rectifier	7.7	4.3%	3,367
Segment total	**$2,212.2**		
Weighted averages		**9.4%**	**$7,977**
Software			
Lotus Development	$83.8	17.9%	$33,535
Computer Associates	81.5	11.5%	18,230
Microsoft	69.8	11.8%	24,982
Management Science America	58.9	23.6%	24,874
Ashton-Tate	52.9	17.2%	42,290
Cullinet Software	52.4	24.2%	21,830
Oracle Systems	25.7	9.1%	11,648
Segment total	**$425.0**		
Weighted averages		**15.0%**	**$23,625**

Minisuper shakeout survivors foresee a revived market

As Digital Equipment readies its entry, buyers struggle to sort out confusion that stems from many contenders with rival technologies

BY ROBERT HAAVIND

Although the crowded, highly competitive minisupercomputer market has been in the doldrums — falling far short of its advance billings of only a couple of years ago — a strong revival is expected. Industry analysts and executives nonetheless temper their optimistic consensus with a note of caution.

"I think the worst is over," says Jeffry Canin, an independent analyst based in San Francisco, who monitors the minisupercomputer market. But it will be another 18 months before the shakeout period comes to a complete end and good times return for the survivors, he believes.

The wild card in the market — and a major impetus for the expected resurgence — is Digital Equipment Corp. DEC is due to unveil a system with minisupercomputer performance later this year. Potential buyers of minisupers have delayed purchases until they see what DEC has to offer, vendors and analysts say.

"We look at DEC as a benchmark for the industry," says George Weiss, an analyst for the Gartner Group market research firm. If the DEC entry is viewed positively, Weiss and other observers believe, the entire field will expand and the survivors will benefit, despite competition from DEC.

Projected three years ago as an explosive market that would top $1 billion in sales by 1991, most industry watchers now agree that worldwide minisupercomputer sales have grown at a much slower rate. But analysts' estimates of the size of the minisupercomputer market vary because each defines the market a bit differently. (Gartner Group, for example, includes systems from Ardent Computer Corp. and Stellar Computer Inc. in its figures, while Dataquest Inc. includes systems from Gould Inc., even though others classify Gould computers as high-end minicomputers.

Gartner Group estimates that total sales of minisupercomputers were $335 million in 1988 and will reach $445 million this year. Dataquest senior industry analyst Chris Willard, who uses the term "departmental supercomputers" to describe the market, puts 1988 sales at $246 million. Willard believes that minisupercomputer sales will hit $838 million by 1993 — a compound annual growth rate of 27.8%

Alliant president Ron Gruner believes the minisupercomputer market will react like the workstation market: it will "take off" once the big players, like DEC, enter

Fills technical-computing niche

Minisupercomputers occupy a key niche in the technical-computing market, which makes up about 20% of the total computing marketplace, Dataquest estimates. Technical-computing applications include engineering, structural design, military systems, and scientific research. At prices ranging from $100,000 for superworkstations up to $1 million or even $2 million, the performance of minisupercomputers fits between high-end mainframes and full-fledged supercomputers.

The market for minisupercomputers came on the scene about the time the workstation market exploded in the mid-1980s. Users found that, although convenient, workstations did not have the storage capacity or computational power needed for complicated calculations.

Despite the promising outlook, the minisupercomputer market failed to take off. After fast growth in the mid-'80s, confusion in the marketplace played a major role in the slowdown,

observers agree. Attracted by the projections, venture capital poured into a proliferation of start-ups. Some 20 companies were offering systems, many based on exotic architectures. Users were forced to consider assorted technology options, while no large, established companies were serving the niche. This raised concerns about maintenance and software support, and the aggregate result was delayed buying decisions.

The fierce competition forced prices down, and a number of companies had to close their doors in late 1987 and 1988, such as Culler Scientific Systems Corp. and Saxpy Computer Corp. Earlier this year, Cydrome Inc. went into Chapter 11 as a result of Prime Computer Inc. pulling the plug on its investment in the company last year. FPS Computing bought Celerity Computing, and Scientific Computer Systems Corp. of San Diego dropped its Cray-compatible minisupercomputer line. In May, Control Data Corp. shut down its subsidiary ETA Systems Inc., which sold systems from the high end of the minisupercomputer range on up.

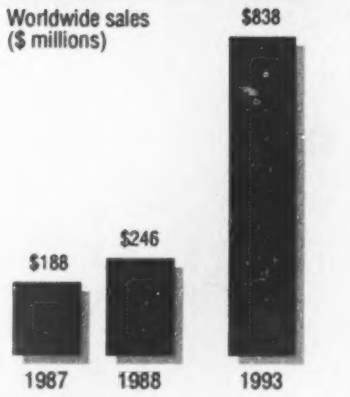
Vendors that entered the market early, that had strong marketing programs and that offered acceptable technology have the best chance for success in the shakeout, Willard says. Those that make it through the next year, he believes, will have bright prospects.

Head of the class

The market leader, Convex Computer Corp. in Richardson, Texas, continued to be profitable through last year, earning $5.7 million on sales of $105.6 million. Much of Convex's success came from its decision to offer high-end minisupercomputers, thus avoiding the bloody price battles taking place in the market. Convex sees itself competing at the low end of the supercomputer market and, in fact, now simply calls itself a supercomputer, rather than a minisuper, vendor. At the end of June, Control Data announced an agreement to sell Convex's C Series family of minisupers.

The No. 2 company, Alliant Computer Systems Corp. of Littleton, Mass., was not as fortunate as Convex, suffering losses of about $36 million on sales of $65 million. Alliant, stung by the loss of a number of key

Minisupercomputer market growth



Source: Dataquest Inc.

executives early last year, has returned to profitability this year after undergoing a restructuring.

Alliant assumed a strategy different from Convex, unveiling smaller versions of its FX/Series minisupercomputers at lower prices. Although this put Alliant in the thick of the competition during the shakeout, company executives argue that the low-end systems ultimately will attract a broader market.

Unlike vendors that focus on scientific and technical markets, Multiflow Computer Inc. in Branford, Conn., has adopted a strategy that includes marketing its Trace minisupercomputers for commercial applications as well. The Trace systems are based on what Multiflow describes as a "very-long-instruction-word" architecture, which carries out multiple instructions simultaneously and so boosts performance up to 10 times that of other computer architectures without the vector processors used by its minisuper rivals.

Minisupercomputers occupy a key niche in the technical-computing market

Traditional minisupercomputer vendors are also feeling the competitive heat from marketers of "graphics supercomputers," single-user minisupercomputers with sophisticated graphics capabilities. Systems from Stellar Computer Inc. in Newton, Mass., and Ardent Computer Corp. in Sunnyvale, Calif., are in this class, as is the DN 10000 system from Apollo Computer, now a division of Hewlett-Packard Co.

Sales of single-user systems, with prices that start at about $100,000, will grow at an annual rate of 56% or more through 1993, Dataquest's Willard predicts. Minisupercomputer vendors are responding by forging alliances with manufacturers of graphics workstations or boosting the graphics capabilities of their own systems. Last year, Alliant bought out Raster Technologies Inc., a maker of graphics subsystems based in Westford, Mass., and now sells those subsystems integrated with its FX/Series minisupers.

Client-server network potential

Most vendors feel there is a much larger potential for minisupers in client-server networks, where the engineer or scientist performs less demanding tasks on a local workstation, while computer-intensive work is automatically shuttled to a minisuper. As workstations proliferated, users fought the high cost of duplicating massive files at each desk with centralized "disk farms" run by file servers. Minisuper vendors see this network concept as a big opportunity.

FPS Systems was a leader in client-server networks and first offered an attached 64-bit minisupercomputer with Cray performance for less than $1 million in 1981. More recently, when it bought Celerity, FPS Systems integrated that firm's technology into its modular system and now offers Unix-based standalone processors. The emergence of standards — such as for Unix, network protocols, and graphics — will greatly simplify setting up such client-server networks, according to Craig Mundie, Alliant's vice president for research and development.

A variety of Unix-based client-server minisupercomputer offerings are contending for this emerging market. Pyramid Technology Corp. in Mountain View, Calif., for example, uses reduced instruction set computer (RISC) chips and an I/O processor in the network to speed computation and data flow. Arix Corp. (for-

merly Arete) of San Jose uses Motorola's MC68020 microprocessor and MC68881 floating-point coprocessor, along with Unix V with multiprocessor enhancements for its expandable systems operating from 4 MIPS to 30 MIPS.

Users agree that Ethernet, widely used for data transfer, is too slow for applications in which computation and complex images must be coupled, such as for varying parameters and observing effects in a mechanical design, molecular modeling, or scientific simulation. Even though optical-fiber links have been installed in many technical-computing shops, current standards keep data transfer at the same rates as on copper wires.

Faster communications must await the Fiber Distributed Data Interface (FDDI) standard for optical data transfer expected later this year, according to Frank Vince, vice president for marketing at Convex. To help with this problem, companies such as Aptec Computer Systems Inc. in Portland, Ore., which makes a specialized I/O computer, are helping users to speed data flow among diverse peripherals, mainframes, and workstations for applications such as signal-image processing, scientific computing, and simulations such as seismic modeling for oil and gas exploration.

DEC will add legitimacy

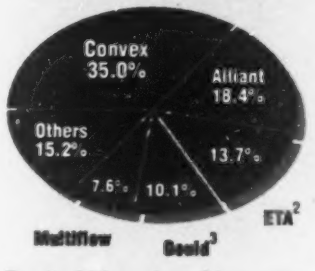
The entry of DEC, the technical-computing leader, into the minisupercomputer marketplace will help add legitimacy to this sector, Alliant president Ron Gruner believes.

"The workstation market was not doing that well in 1985, when DEC came out with its VAXstation II and IBM introduced its RT PC, but then it took off," he argues. And, he points out, competitors of the two giants were big winners in the surging market. Stepped-up workstation buying since 1985 has taken a large portion of technical computing budgets, and as users begin to recognize the limitations of desktop systems, Gruner feels, they will want to be linked to computational engines such as minisupercomputers.

Potential customers who have delayed buying minisupercomputers while waiting for DEC to enter the minisupercomputer fray should now have a basis for making a buying decision. "It's a lot easier to benchmark against a real machine," analyst Canin notes.

Minisupercomputer makers' market share

Worldwide systems sales[1]



Total 1988 market: $246 million

[1] Excludes add-on products and service-related revenue
[2] Suspended operations April 1989
[3] Does not include Encore

Source: Dataquest Inc.

Although DEC declined to discuss its plans, the Maynard, Mass., giant is expected to unveil a system — internally called Aridus — sometime this fall. By offering 30 MIPS of power per processor, the Aridus multiprocessor is expected to compete in both commercial and technical markets against other minisupercomputers.

Last month DEC said it is developing an add-on vector processor that will boost the computational capabilities of its VAX computers. IBM sells a similar product, called the 3090 VF, which increases the computational power of its 3090 mainframe.

The entry of DEC will help add legitimacy to the sector

"DEC's moves make good sense, but it appears to be planning to compete more against IBM than the minisupers," Convex's Vince suggests. As ETA Systems was leaving the market, Convex raised the top of its line into the $2 million to $2.5 million range with the C2-40, which has four vector-parallel processors. The system offers three to four times the power of a VAX 8700, with an architecture similar to Cray's X-MP 4-6, Vince says, but with hardware enhancements to make the system more fine-grained.

New parallel machines

Newer types of systems are generally first bought by government users, often the military, justifying development of a single large application, Dataquest's Willard says. Once a new architecture has been tested by research and university laboratories and catches on across the government marketplace, it moves out into the commercial sector. Some minisupers have made that transition, but a few of the new parallel architectures are still in the evaluation process.

"In the early '70s, the rage was for vector processors," Willard says. "Today, it is for highly parallel machines."

Scientific visualization is cited as the fastest-growing application area for minisupercomputers, including molecular engineering, oil-field modeling, structural/mechanical design, military systems, and scientific research.

One bright spot for some minisuper vendors has been the healthy expansion of overseas markets, particularly in Europe and Japan. Alliant set up a subsidiary in Japan, which grew from a five-person staff early last year to more than 110 today. More than half of the company's sales in the first quarter of 1989 were in Japan, according to Gruner, and he expects sales to split evenly among Japan, Europe, and the United States by 1992. Convex also has had good sales in Japan; this is probably because the Japanese computer companies seem intent on competing against IBM and Cray in the larger supercomputer sector rather than in the minisuper range, according to marketing vice president Vince.

European customers have been quicker to make decisions than many U.S. technical shops, Gruner says, perhaps because the companies there feel pressure to keep ahead of the tough competition in the United States and Japan. Considerable pent-up demand in the U.S. market will begin to break loose, he predicts, now that the earlier market confusion is being sorted out and DEC is getting its entry ready.

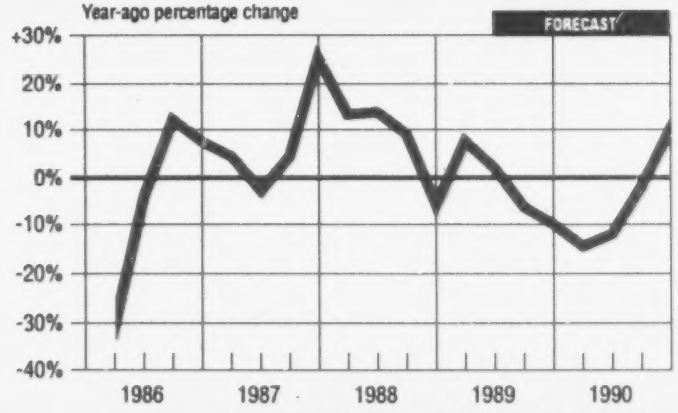
If so, the early rosy projections could come true after all, just a little later than expected. □

Leadtimes in detail

Average delivery times in weeks	2nd qtr. 1987	2nd qtr. 1988	2nd qtr. 1989	FORECAST 2nd qtr. 1990
Discrete semiconductors	6.5	7.8	7.9	7.4
Integrated circuits	6.7	7.5	8.3	7.5
Memory circuits	7.1	14.3	11.3	11.3
Microprocessors	7.4	9.1	8.4	9.4
Displays	7.6	7.9	9.9	6.6
Capacitors	6.6	6.9	7.5	5.6
Connectors	7.4	6.3	6.5	6.9
Printed circuit boards	6.4	5.8	6.5	5.3
Relays	8.0	8.2	8.8	8.2
Resistors	5.5	4.8	5.4	5.3
Switches	6.5	6.5	7.4	6.5
Wire and cable	4.6	3.8	4.2	4.6

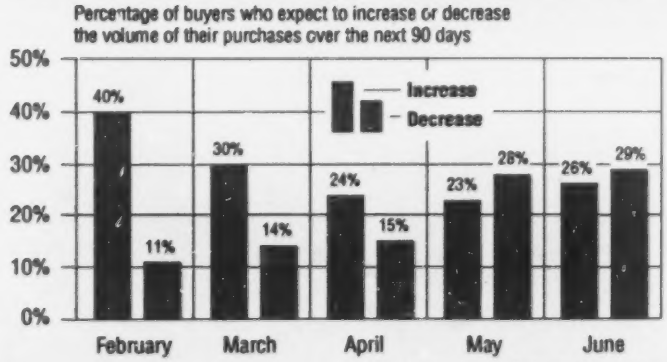
Data source: *Electronics Purchasing*; Forecast: Cahners Economics

Electronic component leadtimes



Data source: *Electronics Purchasing*; Forecast: Cahners Economics

Component buyers' expectations



Data source: *Electronics Purchasing*

Buyer survey hints at industry slowdown ahead

Delivery times for some key electronic components continued to shorten in the spring quarter of this year, according to *Electronics Purchasing* magazine's survey of buyers. Other component leadtimes, meanwhile, inched up from last spring's levels. This mixed performance in delivery times probably signals neither great growth nor a recession, but simply a flat period ahead.

Why no recession? Compare current leadtime performance with the last recession's performance. Four years ago, leadtimes fell below year-ago levels for seven consecutive quarters, toppling at a 48% year-ago rate in the autumn of 1985. Now, leadtimes for all components are forecast to fall for just five consecutive quarters, and may actually pop up once or twice during this period. The severity of the upcoming leadtime decline will be muted as well, with leads expected to drop at only a 14% rate in the early months of next year.

Buyers signal falling DRAM prices

Leadtimes for particular components also give some warning on the probable direction of future pricing. When delivery times get significantly faster, the ability of component manufacturers to raise prices is limited. If leadtimes fall fast enough, price declines may even be likely. When delivery times slow, the chances are that demand is greater than supply and price increases are more likely.

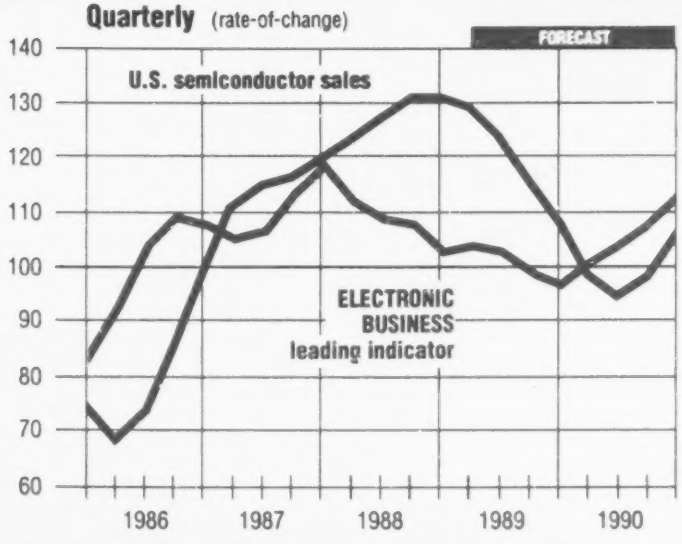
For example, take a look at what buyers are saying about the 1Mb DRAM availability and pricing situation. Delivery times for 1Mb DRAMs fell to 12 weeks in June, down from 23 weeks a year earlier. That 11-week decline in leadtimes has indeed been accompanied by falling DRAM prices. In a separate price survey, *Electronics Purchasing* magazine asks buyers what price they are actually paying for particular components. In the June 1989 survey, the typical buyer indicated 1Mb DRAM prices averaged $15.12, down from last year's $26.22.

Buyers are also telling us more directly that a slowdown is ahead. When asked what their purchasing plans are for components over the next 90 days, only 26% said they'd be increasing the volume of components bought in the latest June survey, down from 40% in the February survey. Meanwhile, the percentage expected to decrease their purchases has risen from 11% in February to 29% in June.

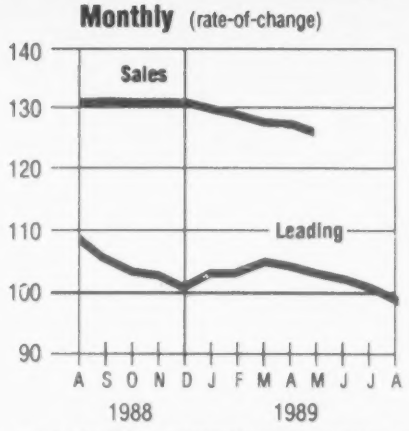
ELIZABETH B. BAATZ

A column on leadtimes is scheduled to appear again in the November 13th issue

ELECTRONIC BUSINESS leading indicator



The ELECTRONIC BUSINESS leading indicator predicts turning points in U.S. semiconductor sales with about a three- to nine-month leadtime. For more information please contact Elizabeth Baatz, senior economist, Cahners Publishing Co., 275 Washington St., Newton, Mass., 02158, or call (617) 558-4368



The ELECTRONIC BUSINESS leading indicator fell to 103.8 in April, down from 104.6 in March. The indicator has fallen 14% in the past year-and-a-half since peaking back in October 1987. This compares to the 44% collapse in the indicator during the year-and-a-half following the early 1984 peak. Clearly the indicator now says the 1989 downturn willl be much milder than the last electronics industry recession.

Source: Cahners Economics

Electronics industry indicators this month

	Latest month	Previous month	Year ago	1988 average
ELECTRONIC BUSINESS leading indicator (rate-of-change, April)	103.8	104.6	109.4	107.6
U.S. semiconductor bookings ($ millions, 3-month average, May)	$1,286	$1,358	$1,258	$1,178
Weekly hours of semiconductor production workers (monthly average, April)	40.2	39.5	39.3	40.2
Electronic components leadtime index (1977 = 100, June)	120.6	110.6	120.2	108.9
S&P's semiconductor stock price index (1970 =10, monthly average, May)	55.9	51.3	58.2	54.4
Change in electronic components inventories ($ millions, SA, April)	+$11	+$10	+$18	+$80
Contracts and orders for plant and equipment ($ billions, SA, April)	$44.4	$42.7	$37.8	$39.4

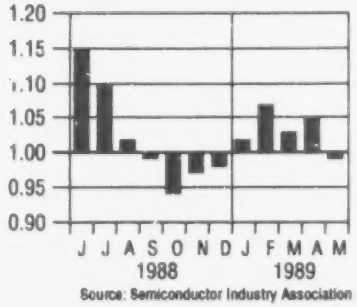
SA = seasonally adjusted, all other data is not seasonally adjusted

Sources: Semiconductor Industry Association, U.S. Bureau of Labor Statistics, *Electronics Purchasing* magazine, Standard & Poor's, U.S. Commerce Department, U.S. Bureau of Economic Analysis

Semiconductor sales

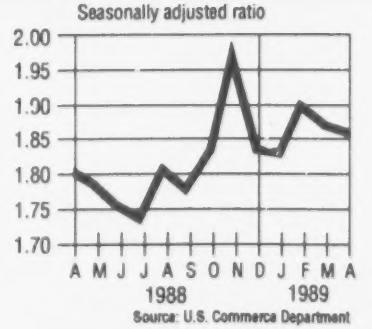
Source: Semiconductor Industry Association

Semiconductor book-to-bill ratio



Source: Semiconductor Industry Association

Component inventory-to-shipments



Source: U.S. Commerce Department